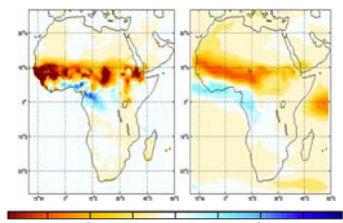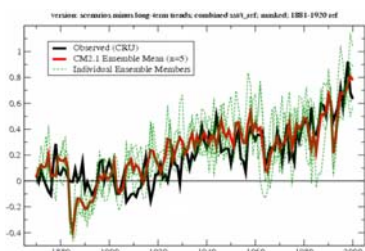# Geophysical Fluid Dynamics Laboratory
Modeling the Earth's climate and weather

Observed and modeled diagrams of rainfall change in the Sahel, in mm/month between the years 1980-2000 and 1940-1960

Observed and modeled global mean temperature trends

Ocean temperature anomalies at peak of an El Niño event (red indicates at least 1°C above normal, blue indicates at least 1°C below normal)

Hurricane Isabel Track and Sea Temperature Forecast

**1315 East West Highway
Silver Spring, MD 20910
(301) 713-1671
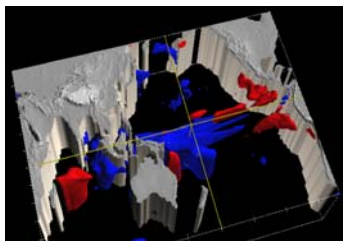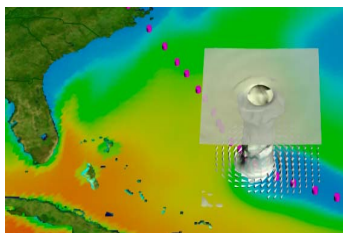www.oar.noaa.gov**

What does the Geophysical Fluid Dynamics Laboratory do for the nation?

The Geophysical Fluid Dynamics Laboratory (GFDL) develops and uses mathematical models and computer simulations to improve our understanding and predictions of the behavior of the atmosphere, the oceans, and climate.

GFDL focuses on model-building relevant for NOAA operations, such as hurricane research, prediction, and seasonal forecasting, and understanding global climate change. To conduct this research, GFDL scientists create and operate complex computer applications using state-of-the-art supercomputer and data storage resources. These mathematical models have become key tools, not only in predicting tomorrow's weather, but also in understanding the physical processes that control near-term weather, as well as the earth's climate years into the future. Over its 45-year history, GFDL has set the agenda for much of the world's research on the modeling of global climate change and has played a significant role in the World Meteorological Organization and Intergovernmental Panel on Climate Change (IPCC) assessments. Many of the key scientific issues in climate change were first addressed in papers published by GFDL.

Based on model simulations, theory, and observational studies, research at GFDL has resulted in a host of insights into fundamental atmospheric and oceanic processes, including tropical variability, midlatitude storm tracks, stratospheric ozone depletion, atmospheric responses to the El Niño-Southern Oscillation, global ocean circulation, chemical transport in the atmosphere, and the effect of clouds on sunlight reaching the Earth's surface. This broad set of activities leads to more accurate prediction of phenomena in the atmosphere and oceans and on land over daily, seasonal, decadal and centennial time scales.

Recent Accomplishments:

- GFDL's new "state-of-the-art" coupled climate model provided data to the world's research communities for the IPCC Fourth Assessment Report on Climate Change (2007). Evaluations presented at a recent IPCC workshop revealed the GFDL model to be one of the best in the world by a variety of measures. **Payoff: The GFDL climate model can be widely used to make valuable contributions to national and international climate assessments, such as those produced by the Climate Change Science Program and the IPCC. The model can also facilitate our understanding of past and present climate variability and change and potential causes, both natural and human-induced.**

- GFDL continues to contribute to NOAA's seasonal forecasting mission using the same model being used for long-term climate projections. Work is ongoing to improve the ocean data assimilations systems required to initialize seasonal forecasts and to utilize the rapidly developing global ocean observing system. Experimental forecasts are provided to other parts of NOAA Research, the National Weather Service, and the broader research community. **Payoff: GFDL puts state-of-the-art modeling technology to practical use and serves as an important input toward NOAA's long lead time forecasts. It improves the skill in forecasting future El-Niño events known to produce adverse weather effects around the world.**

- GFDL's Modular Ocean Model (MOM), an evolving code that GFDL uses to model climate, to research seasonal-to-interannual variability and predictability, and to model the carbon cycle, was completely modernized. Special new features include ice prediction as well as an ability for adding or subtracting fresh water in a mass and energy conserving fashion. **Payoff: The state-of-art MOM can now be used by GFDL and other outside researchers to perform oceanographic, weather, and climate studies. Over 280 scientists around the world are now using MOM.**

- GFDL continues to make spectacular improvements in hurricane track prediction. The average track error for a 5 day forecast of Hurricane Isabel (2003) was reduced by approximately 25% as compared with the weather service global model. Realistic forecasts of hurricane tracks have been extended from 72 to approximately 120 hours. GFDL scientists have successfully coupled the hurricane prediction model with a full ocean model which they have used to conduct studies on hurricane intensity prediction. **Payoff: The GFDL hurricane prediction model continues to show track forecasting improvements per year of 10%. Skill is also being demonstrated for prediction of hurricane intensities.**

What's next for GFDL?

- Providing the latest climate model data through GFDL's new data portal to better serve NOAA's climate data customers. This data includes output from the runs performed for the IPCC Fourth Assessment report, and other runs performed to meet the scientific goals of the Climate Change Science Program.
- Implementation of an Earth system modeling capability which includes interactive oceanic and terrestrial ecosystems (carbon cycle), biogeochemical cycles, and atmospheric chemistry which will provide new forecasting and analyses capabilities for NOAA for ecosystems, climate and air quality, and coastal pollution.
- Modifying the Hurricane Forecast System to improve use of new data sources inside or near hurricanes.
- Focusing research on climate change detection/attribution and assessing the roles of natural climate variability and human-related causes in climate change. This work is critical for evaluating the credibility of mathematical models for providing reliable projections of future climate change and of how the Earth's ecosystems will be affected.

Research Partnerships

GFDL has research partnerships with many organizations inside and outside of NOAA, totaling several hundred active collaborations. Within NOAA, GFDL has active research programs with other NOAA Research laboratories and the National Weather Service National Centers for Environmental Prediction. GFDL scientists also have collaborations with the National Science Foundation, the University Corporation for Atmospheric Research, NASA, Department of Energy, various partners within the academic community, overseas research institutions, and others. GFDL works with the Cooperative Institute for Climate Science, a cooperative institute between NOAA and Princeton University's Atmospheric and Oceanic Sciences Program. A complete listing of GFDL's research collaborations is available on the GFDL website.

Budget and Staff

The fiscal year 2006 enacted budget for GFDL is $16.7M and the fiscal year 2007 President's budget request is $17.3M. GFDL currently has 110 permanent Federal employees.

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